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DESCRIPTION

WIRELESS COMMUNICATION APPARATUS AND WIRELESS
COMMUNICATION METHOD

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Technical Field

The present invention relates to a wireless communication and reception quality reporting method, and particularly relates to a wireless communication apparatus and reception quality reporting method for performing high-speed packet communication using adaptive modulation and scheduling.

Background Art

In a conventional art, in HSDPA (High-Speed Downlink Packet Access) of 3GPP, adaptive modulation where the modulation scheme is adaptively controlled according to propagation path conditions and scheduling for transmitting a user signal for which propagation path conditions are comparatively superior have been employed in downlink high-speed packet transmission.

In multi-carrier transmission such as OFDM and MC-CDMA (for example, Hara, Kawabata, Duan and Sekiguchi, "MC-CDM System for Packet Communications Using Frequency Scheduling", TECHNICAL REPORT OF IEICE, RCS2002-129, July 2002, refer to pp. 61-66) being examined as transmission schemes for beyond 3G mobile communication systems, high

speed transmission is implemented using a large number of sub-carriers.

In this kind of transmission scheme, performing adaptive modulation and scheduling every sub-carrier is
5 examined.

With this kind of adaptive modulation and scheduling system, it is necessary for the mobile station to give reporting of channel quality information (CQI (Channel Quality Indicator)) of each sub-carrier instantaneously
10 at a base station.

The mobile station reports individual CQI's on every sub-carrier for all sub-carriers to the base station.

A base station then determines the sub-carrier, modulation scheme and encoding rate to be used at each
15 mobile station in accordance with a predetermined scheduling algorithm taking into consideration the CQI's from each mobile station.

Typically, sub-carriers with comparatively good propagation path conditions are allocated to each mobile
20 station, and a modulation scheme and encoding rate satisfying a predetermined packet error rate are employed for these propagation conditions.

In the event that a base station transmits to a plurality of mobile stations at the same time, frequency
25 scheduling is carried out using CQI's of all of the sub-carrier from all of the users.

In other words, if there are 64 sub-carriers, it

is necessary for each mobile station to give reporting of 64 CQI's.

In this event, when a CQI is expressed using five bits, it is necessary to transmit a total of $64 \times 5 = 5$ 320 bits per one user in each wireless frame.

However, with wireless communication apparatus of the conventional art, the quantity of signal required for CQI reporting is enormous. This means that interference incurred by other data channels and other 10 cells is large, and the quantity of data that can be transmitted is therefore substantially reduced.

Further, as the quantity of signal for giving CQI reporting is enormous, power consumption of the mobile station is increased and a battery life is shortened.

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Disclosure of Invention

It is an object of the present invention to provide a wireless communication apparatus and reception quality reporting method capable of increasing the data capacity 20 that can be transmitted and reducing power consumption by reducing the amount of control signal transmitted, and increasing system capacity by reducing interference with respect to other wireless communication apparatuses.

According to an aspect of the present invention, 25 a wireless communication apparatus is comprised of a measuring section that measures reception quality of a plurality of sub-carriers within a communication band

from a received signal every sub-carrier, a selecting section that selects a sub-carrier satisfying a predetermined condition relating to measured reception quality from the plurality of sub-carriers, and a 5 reporting section that gives a reporting of a selection result of the selecting section.

According to a further aspect of the present invention, a base station apparatus is comprised of a modulating section that modulates a packet data using 10 an M-ary number adaptively selected based on a reporting of a selection result in which a sub-carrier satisfying a predetermined condition relating to reception quality at an opposing communication apparatus from a plurality of sub-carriers within a communication band, an encoding 15 section that encodes the packet data using an encoding rate adaptively selected based on the reporting, and a scheduling section that identifies a sub-carrier satisfying the predetermined condition based on the reporting and carries out scheduling so that a packet 20 data of a higher M-ary number or encoding rate to an identified sub-carrier having superior reception quality.

According to a further aspect of the present invention, a reception quality reporting method is 25 comprised of a measuring step of measuring reception quality of a plurality of sub-carriers within a communication band from a received signal every

sub-carrier, a selection step of selecting a sub-carrier satisfying a predetermined condition relating to measured reception quality from the plurality of sub-carriers, and a reporting step of giving a reporting of a selection
5 result of the selecting section.

Brief Description of Drawings

FIG.1 is a block diagram showing a configuration of a wireless communication apparatus of Embodiment 1
10 of the present invention;

FIG.2 is a block diagram showing a configuration of a base station apparatus of Embodiment 1 of the present invention;

FIG.3 is a diagram showing an arrangement of
15 sub-carriers on a frequency axis of Embodiment 1 of the present invention;

FIG.4 is a diagram showing a signal format of Embodiment 1 of the present invention;

FIG.5 is a diagram showing a signal format of
20 Embodiment 1 of the present invention;

FIG.6 is a block diagram showing a configuration of a wireless communication apparatus of Embodiment 2 of the present invention;

FIG.7 is a block diagram showing a configuration
25 of a wireless communication apparatus of Embodiment 3 of the present invention;

FIG.8 is a block diagram showing a configuration

of a base station apparatus of Embodiment 3 of the present invention;

FIG.9 is a diagram showing a signal format of Embodiment 3 of the present invention;

5 FIG.10 is a block diagram showing a configuration of a wireless communication apparatus of Embodiment 4 of the present invention;

FIG.11 is a block diagram showing a configuration of a base station apparatus of Embodiment 4 of the present 10 invention;

FIG.12 is a diagram showing a signal format of Embodiment 4 of the present invention;

FIG.13 is a diagram showing a signal format of Embodiment 4 of the present invention;

15 FIG.14 is a block diagram showing a configuration of a wireless communication apparatus of Embodiment 5 of the present invention; and

FIG.15 is a block diagram showing a configuration of a base station apparatus of Embodiment 5 of the present 20 invention.

Best Mode for Carrying Out the Invention

The following is a detailed description of embodiments of the present invention with reference to 25 the accompanying drawings.

(Embodiment 1)

FIG.1 is a block diagram showing a configuration

of wireless communication apparatus 100 of Embodiment 1 of the present invention.

Reception wireless processing section 102 down converts and suchlike a received signal received at 5 antenna 101 from a radio frequency to a baseband frequency. and outputs to guard interval (hereinafter referred to as "GI") removing section 103.

GI removing section 103 removes GI's from a received signal inputted from reception wireless processing 10 section 102 and then outputs to fast Fourier transform (hereinafter referred to as "FFT; Fast Fourier Transform") section 104.

After converting the received signal inputted from GI removing section 103 from a serial data format to a 15 parallel data format, FFT section 104 subjects the received signal to FFT and outputs to control information extraction section 105, user data extraction section 108 and pilot signal extraction section 112.

Control information extraction section 105 extracts 20 control information contained in CQI quantity information transmitted from the base station apparatus from the received signal inputted from FFT section 104 and outputs to demodulating section 106.

Demodulating section 106 subjects control 25 information inputted by control information extraction section 105 to demodulation processing and outputs to a decoding section 107.

Decoding section 107 decodes demodulated control information inputted by demodulating section 106, outputs decoded control information, and outputs CQI quantity information contained in the control information to 5 sub-carrier selecting section (hereinafter referred to as "SC selecting section) 127.

User data extraction section 108 extracts user data from the received signal inputted by FFT section 104 and outputs to demodulating section 109.

10 Demodulating section 109 subjects user data inputted by user data extraction section 108 to demodulation processing and outputs to reception HARQ (Hybrid Automation Repeat Request) section 110.

If user data inputted by demodulating section 109 15 is new data, reception HARQ section 110 saves all or part of the user data and outputs the user data to a decoding section 111.

If the user data inputted by demodulating section 109 is re-transmitted data, reception HARQ section 110 20 combines the saved user data with the re-transmitted data, saves the combined user data, and outputs the combined user data to decoding section 111.

Decoding section 111 decodes user data inputted by reception HARQ section 110 and outputs user data.

25 Further, decoding section 111 performs error detection and decoding, and outputs the result to ACK/NACK generating section 119.

The error detection may use CRC (Cyclic Redundancy Checks).

This error detection is not limited to CRC and arbitrary error detection methods may also be applied.

5 Pilot signal extraction section 112 extracts a pilot signal from the received signal inputted by FFT section 104 and outputs to reception quality measuring sections 113-1 to 113-n.

Reception quality measuring sections 113-1 to 113-n
10 are provided for the useable number of sub-carriers. Reception quality measuring sections 113-1 to 113-n measures reception quality every sub-carrier for all of the sub-carriers using a pilot signal inputted from pilot signal extraction section 112. Measurement value
15 information indicating reception quality every measured sub-carrier is outputted to CQI generation section 114 and SC selecting section 127.

Arbitrary measurement values such as CIR (Carrier to Interference Ratio), SIR (Signal to Interference Ratio) and suchlike measured every sub-carrier can be used for the measurement value information.

CQI generating section 114 constituting a reception quality information generating section compares measurement value information inputted by reception
25 quality measuring section 113 with a plurality of threshold values (second threshold values) for CQI selection use set according to reception quality, for

a sub-carriers of a sub-carrier number (hereinafter referred to as "SC number") information that is identification information inputted from SC selecting section 127, and selects and generates a CQI every 5 sub-carrier.

In other words, CQI generating section 114 has a reference table that stores information for CQI selection use to which different CQI's are allocated every predetermined region for measurement values indicating 10 reception quality separated by threshold values for use in selection of the plurality of CQI's, and selects CQI's by referring to information for CQI selection use employing measurement value information inputted by a reception quality measuring section 113.

15 CQI generating section 114 generates one CQI for one sub-carrier and therefore generates CQI's for the designated number of sub-carriers.

CQI generating section 114 outputs the generated CQI's to an encoding section 115.

20 Generation of a CQI is not limited to after selection of a sub-carrier and it is also possible to select a generated CQI based on CQI quantity information after generating CQI's for all of the sub-carriers.

Encoding section 115 encodes CQI's for the number 25 of designated sub-carriers inputted by CQI generating section 114 and outputs to modulating section 116.

Modulating section 116 modulates CQI's inputted by

encoding section 115 and outputs to multiplexer 122.

Encoding section 117 encodes SC number information inputted by SC selecting section 127 and outputs to modulating section 118.

5 Modulating section 118 modulates SC number information inputted by encoding section 117 and outputs to multiplexer 122.

ACK/NACK generating section 119, according to error detection result information inputted by decoding section
10 111, generates a NACK signal constituting an error determination signal if re-transmission is necessary, generates an ACK signal constituting an error determination signal in the event that re-transmission is not necessary, and outputs the generated NACK signal
15 and ACK signal to an encoding section 120.

Encoding section 120 encodes a NACK signal or ACK signal inputted by ACK/NACK generating section 119 and outputs to modulating section 121.

Modulating section 121 modulates a NACK signal or
20 ACK signal inputted by encoding section 120 and outputs to multiplexer 122.

Multiplexer 122 multiplexes CQI's inputted by modulating section 116, SC number information inputted by modulating section 118, and NACK signals or ACK signals
25 inputted by modulating section 121 so as to generate transmission data and outputs the generated transmission data to a serial/parallel (hereinafter referred to as

"S/P") converter 123.

S/P converter 123 converts transmission data inputted by multiplexer 122 from a serial data format to a parallel data format and outputs to inverse fast Fourier transform (hereinafter referred to as "IFFT: Inverse Fast Fourier Transform") section 124.

IFFT section 124 subjects transmission data inputted by S/P converter 123 to inverse fast Fourier transformation and outputs to GI insertion section 125.

GI insertion section 125 inserts GI's into transmission data inputted from IFFT section 124 and outputs to transmission wireless processing section 126.

Transmission wireless processing section 126 upconverts transmission data inputted from GI insertion section 125 from a baseband frequency to a radio frequency and transmits from antenna 101.

SC selecting section 127 constituting a selecting section selects a number of sub-carriers designated by the CQI quantity information in descending order of reception quality using CQI quantity information inputted by decoding section 107 and measurement value information inputted by reception quality measuring sections 113-1 to 113-n.

SC selecting section 127 then outputs the selected sub-carriers as SC number information to CQI generating section 114 and encoding section 117.

In this way, SC selecting section 127 selects the

number of sub-carriers designated by control station apparatus.

Not only in the event that the sub-carriers are selected in descending order of reception quality, SC 5 selecting section 127 may also set a predetermined threshold value and select a number of arbitrary sub-carriers designated by the CQI quantity information from sub-carriers of reception quality of the threshold value or higher.

10 Next, a configuration for a base station apparatus as a higher-level station apparatus of wireless communication apparatus 100 is described using FIG.2.

FIG.2 is a block diagram showing a configuration of base station apparatus 200.

15 Control information extraction section 205, demodulating section 206, decoding section 207, encoding section 209, transmission HARQ section 210, modulating section 211, encoding section 212 and demodulating section 213 constitute transmission data processing 20 sections 221-1 to 221-n.

Transmission data processing sections 221-1 to 221-n are provided for the number of users and each of transmission data processing sections 221-1 to 221-n carries out processing on transmission data for 25 transmission to one user.

Further, encoding section 212 and modulating section 213 constitute control data transmission processing

section 220.

Reception wireless processing section 202 down converts a signal received at antenna 201 from a radio frequency to a baseband frequency and suchlike and outputs 5 to GI removal section 203.

GI removal section 203 removes GI from the received signal inputted by reception wireless processing section 202 and outputs to FFT section 204.

After a received signal inputted by GI removal 10 section 203 is converted from serial data format to parallel data format, FFT section 204 separates the received signal for each user and outputs to respective control information extraction section 205.

Control information extraction section 205 then 15 extracts control information from the received signal inputted by FFT section 204 and outputs to demodulating section 206.

Demodulating section 206 then demodulates control 20 information inputted by control information extraction section 205 and outputs to decoding section 207.

Decoding section 207 decodes the received signal inputted by demodulating section 206 and outputs CQI's for each of the designated number of sub-carriers included in the received signal to control section 208.

25 Further, decoding section 207 decodes the received signal inputted by demodulating section 206 and outputs SC number information included in the received signal

to control section 208.

Moreover, decoding section 207 decodes the received signal inputted by demodulating section 206 and outputs a NACK signal or ACK signal included in the received signal 5 to transmission HARQ section 210.

Control section 208 as a scheduling section carries out scheduling based on a scheduling algorithm using CQI's and SC number information for wireless communication apparatus 100 of each user inputted by decoding section 10 207, and adaptively selects MCS (Modulation Coding Schemes) for the M-ary numbers and encoding rates and suchlike.

In other words, control section 208 is capable of determining reception quality every sub-carrier of each 15 wireless communication apparatus 100 using the CQI's and SC number information for each sub-carrier transmitted from the wireless communication apparatus 100 for each user. The MCS is then selected according to reception quality for each sub-carrier of each wireless 20 communication apparatus 100.

Control section 208 has knowledge of the number of sub-carriers, and it is possible to allocate transmission data to be sent to each wireless communication apparatus 100, to each sub-carrier within the range of usable 25 sub-carriers.

At this time, control section 208 carries out the allocation, determining reception quality for

sub-carriers for which CQI's have not been transmitted by wireless communication apparatus 100 as being the poorest.

Control section 208 outputs encoding rate 5 information selected for each sub-carrier to encoding section 209 and outputs modulation scheme information selected for each sub-carrier to modulating section 211, and also outputs information on sub-carriers allocated to each wireless communication apparatus 100 using 10 scheduling to sub-carrier allocation section 215.

Encoding section 209 encodes inputted transmission data based on encoding rate information inputted by control section 208, and outputs to transmission HARQ section 210.

15 Transmission HARQ section 210 outputs transmission data inputted by encoding section 209 to modulating section 211 and temporarily holds transmission data outputted to modulating section 211.

In the event that an NACK signal is inputted by 20 decoding section 207, a re-transmission is requested by wireless communication apparatus 100, and therefore transmission HARQ section 210 outputs temporarily held transmission data for which output is complete to modulating section 211 again.

25 On the other hand, in the event that an ACK signal is inputted by demodulating section 207, transmission HARQ section 210 outputs new transmission data to

modulating section 211.

Modulating section 211 modulates transmission data inputted by transmission HARQ section 210 based on modulation scheme information inputted by control section 5 208 and outputs to multiplexer 214.

Encoding section 212 then encodes control data and CQI quantity information inputted by a control station apparatus (not shown) as a higher-level station apparatus of base station apparatus 200, and outputs to modulating 10 section 213.

The CQI quantity information is not limited to being inputted by the control station apparatus and may also be set by base station apparatus 200.

Further, the CQI quantity information can also be 15 set taking into consideration number of users and volume of traffic.

Moreover, this may be set as a value corresponding to reception capability of every mobile station.

Modulating section 213 modulates control data and 20 CQI quantity information inputted by encoding section 212 and outputs to multiplexer 214.

Multiplexer 214 multiplexes transmission data inputted by modulating section 211 and control data and CQI quantity information inputted by modulating section 25 213 for data to be transmitted to wireless transmission apparatus 100 of each user and outputs to sub-carrier allocation section 215.

CQI quantity information is information specific to the wireless communication apparatus 100 of each user.

Sub-carrier allocation section 215 rearranges multiplexed signals inputted by multiplexer 214 based 5 on sub-carrier information for each wireless communication apparatus 100 inputted by control section 208 and outputs to S/P converter 216.

S/P converter 216 converts transmission data inputted by sub-carrier allocation section 215 from 10 serial data format to parallel data format and outputs to IFFT section 217.

IFFT section 217 subjects transmission data inputted by S/P converter 216 to IFFT and outputs to GI insertion section 218.

15 Transmission data transmitted to each of wireless communication apparatus 100 subjected to IFFT at IFFT section 217 is then allocated to frequency-scheduled sub-carriers at control section 208.

GI insertion section 218 inserts GI's into 20 transmission data inputted from IFFT section 217 and outputs to a transmission wireless processing section 219.

Transmission wireless processing section 219 up converts etc. transmission data inputted from GI 25 insertion section 218 from a baseband frequency to a radio frequency and transmits from antenna 201.

Next, a description is given of a method for selecting

sub-carriers at wireless communication apparatus 100 and format for transmission signals during transmission of the CQI's of the selected sub-carriers using FIGs.3 to FIG.5.

5 FIG.3 is a diagram showing sixty-four sub-carriers allocated within a range of a predetermined communication bandwidth F1.

Base station apparatus 200 sends high-speed packet data to the wireless communication apparatus 100 of all
10 the users using the sub-carriers 1 to 64.

In the event that the reception quality of sub-carriers 11 to 21 and sub-carriers 34 to 41 is good from the reception quality measurement results at reception quality measuring sections 113-1 to 113-n, SC
15 selecting section 127 selects sub-carriers 11 to 21 and sub-carriers 34 to 41.

CQI generating section 114 generates CQI's for only sub-carriers 11 to 21 and sub-carriers 34 to 41, and generates SC number information for sub-carriers 11 to
20 21 and sub-carriers 34 to 41.

On the other hand, CQI generating section 114 does not generate CQI's and SC number information for sub-carriers other than sub-carrier 11 to 21 and sub-carrier 34 to 41.

25 FIG.4 is a diagram showing a format for a signal transmitted from wireless communication apparatus 100 to base station apparatus 200.

Items of six-bit SC number information and five-bit CQI's are then paired together to constitute one item of sub-carrier control information.

As shown in FIG.4, control information outputted by multiplexer 122 is a signal resulting from time-division-multiplexing of a pair of control information items for each sub-carrier for which CQI's are generated at CQI generating section 114 and a one-bit ACK/NACK signal.

FIG.5 is a diagram showing a further example of a format for a signal transmitted from wireless communication apparatus 100 to base station apparatus 200.

One item of sub-carrier control information is constituted by one bit of SC number information and five bits of CQI.

As shown in FIG.5, control information outputted by multiplexer 122 is a signal resulting from time-division-multiplexing of SC number information of 64 bits from the top for 64 sub-carriers, CQI's for only the sub-carriers for which CQI's are generated at CQI generating section 114, and one bit of ACK/NACK signal.

The SC number information is information time-division-multiplexed in order from the first sub-carrier of the 64 sub-carriers, with SC number information for sub-carriers for which CQI's are generated being indicated as "1", and SC number

information for sub-carriers for which CQI's are not generated as "0".

As a result, bit 1, bits 2 to 10, bits 22 to 33 and bits 42 to 64 are indicated as "0", and bits 11 to 21 5 and bits 34 to 41 are indicated as "1".

At base station apparatus 200 receiving the CQI's and SC number information, control section 208 carries out scheduling of each sub-carrier for each wireless communication apparatus 100 by prioritizing allocation 10 of sub-carriers 11 to 21 and sub-carriers 34 to 41.

Further, it can also be considered to map data (for example, control data of high importance or playback data etc.) for which it is necessary to make the number of errors small with respect to the sub-carriers.

15 According to this Embodiment 1, a number of sub-carriers for which reception quality is good designated by a base station apparatus are selected and CQI's are generated and transmitted for the selected sub-carriers. Therefore, it is possible to increase the 20 data capacity that can be transmitted and reduce power consumption by reducing the signal volume transmitted through the uplink and also possible to increase system capacity by reducing interference with respect to other wireless communication apparatuses.

25 Also, according to Embodiment 1, CQI's are generated only for selected sub-carriers and processing time while generating CQI's can therefore be made short. Further,

according to this embodiment, designation upon selecting sub-carriers for which CQI's are generated may be achieved simply by transmitting designation information designating the quantity of CQI's from the base station apparatus. It is therefore possible to reduce the amount of signal transmitted through the uplink without increasing the amount of signal transmitted through the downlink.

10 (Embodiment 2)

FIG.6 is a block diagram showing a configuration for a wireless communication apparatus 600 according to Embodiment 2 of the present invention.

As shown in FIG.6, wireless communication apparatus 15 600 according to Embodiment 2 is of a configuration where SC selecting section 127 is omitted and a threshold value determining section 601 is added in wireless communication apparatus 100 of Embodiment 1 shown in FIG.1.

20 In FIG.6, portions with the same configuration as for FIG.1 are given the same numerals and are not described.

Further, the configuration of the base station apparatus with the exception of sending CQI threshold value information instead of CQI quantity information 25 is the same as the configuration of FIG.2 and is therefore not described.

Decoding section 107 decodes demodulated control

information inputted by demodulating section 106 and outputs control information, and outputs CQI threshold value information contained in the control information to a threshold value determining section 601.

5 CQI generating section 114 generates CQI's for each sub-carrier for all of the sub-carriers using measurement value information inputted by reception quality measuring section 113.

In other words, CQI generating section 114 has a
10 reference table that stores information for CQI selection use to which different CQI's are allocated every predetermined region for measurement values indicating reception quality separated by threshold values for use in selection of the plurality of CQI's, and selects CQI's
15 by referring to information for CQI selection use employing measurement value information inputted by reception quality measuring section 113.

CQI generating section 114 outputs the generated CQI's to threshold value determining section 601.

20 CQI generating section 114 is not limited to the case of generating CQI's for all sub-carriers, and CQI's may be generated after sub-carriers are selected by determining threshold values for reception quality for each sub-carrier.

25 Threshold value determining section 601 as a selecting section selects only CQI's for which the reception quality is greater than or equal to a threshold

value using CQI's, which are inputted by CQI generating section 114, and CQI threshold value information, which is a first threshold value inputted by decoding section 107, outputs the selected CQI's to encoding section 115, 5 and outputs SC number information for the selected CQI's to encoding section 117.

Specifically, in the case of using CQI for eight levels of level 1 to 8, only CQI's of level 5 or greater are selected when a threshold value is level 5 or more, 10 and only CQI's of level 4 or greater are selected when a threshold value is level 4 or more,.

Threshold value determining section 601 is capable of adopting a method of outputting information for eight levels indicating which level of eight levels, level 1 15 to level 8, a selected CQI is at, or a method of outputting information of a relative value where, in the event that, for example, a threshold value is level 5 or more and a generated CQI is level 7, a value 2 that is a relative value with respect to the threshold value is outputted.

20 In the case of adopting the method of outputting information for eight levels, three bits are required in order to express levels 1 to 8. In the case of adopting a method of outputting relative value information, if a difference in threshold value is 0 to 3, then only two 25 bits of information are sufficient. The amount of signals transmitted can therefore be reduced in the case of transmitting relative value information.

In the case of adopting the method of outputting relative value information, the base station stores threshold value information which is in common with wireless communication apparatus 600.

5 The method for selecting CQI's at wireless communication apparatus 600 and format for transmitting signals during transmission of the selected CQI's is the same as for FIG.3 to FIG.5 and is therefore not described.

According to Embodiment 2, the present invention
10 selects sub-carriers satisfying reception quality of a threshold value or more designated by the base station apparatus and generates and transmits CQI's for the selected sub-carriers. By reducing the signal volume transmitted through the uplink, it is possible to increase
15 the data capacity that can be transmitted and reduce power consumption, and, by reducing interference with respect to other wireless communication apparatuses, it is possible to increase system capacity..

Further, according to Embodiment 1, designation upon
20 selecting sub-carriers for which CQI's are generated may be achieved simply by transmitting designation information designating a threshold value from the base station apparatus. It is therefore possible to reduce the amount of signal transmitted through the uplink
25 without increasing the amount of signal transmitted through the downlink.

(Embodiment 3)

FIG.7 is a block diagram showing a configuration of a wireless communication apparatus 700 according to Embodiment 3 of the present invention.

5 As shown in FIG.7, wireless communication apparatus 700 of Embodiment 3 is of a configuration where encoding section 117, demodulating section 118, and SC selecting section 127 are removed, and threshold value determining section 701, used sub-carrier selecting section 702 and
10 spreading section 703 are added in wireless communication apparatus 100 of Embodiment 1 shown in FIG.1.

In FIG.7, portions with the same configuration as for FIG.1 are given the same numerals and are not described.

CQI generating section 114 generates CQI's for each
15 sub-carrier for all of the sub-carriers using measurement value information inputted by reception quality measuring section 113.

In other words, CQI generating section 114 has a reference table that stores information for CQI selection
20 use to which different CQI's are allocated every predetermined region for measurement values indicating reception quality separated by threshold values for use in selection of the plurality of CQI's, and selects CQI's by referring to information for CQI selection use
25 employing measurement value information inputted by reception quality measuring section 113.

CQI generating section 114 outputs the generated

CQI's to threshold value determining section 701.

The CQI generating section is not limited to the case of generating CQI's for all sub-carriers, and CQI's may be generated after sub-carriers are selected by 5 determining threshold values for reception quality for each sub-carrier.

Threshold value determining section 701 as a selecting section selects only CQI's for which the reception quality is greater than or equal to a threshold 10 value using CQI's, which are inputted by CQI generating section 114, and CQI threshold value information, which is inputted by decoding section 107, outputs the selected CQI's to encoding section 115, and outputs SC number information for the selected CQI's to used sub-carrier 15 selecting section 702.

As with the threshold value determining section 601 of Embodiment 2, threshold determining section 701 is capable of threshold value determination adopting either of a method of outputting information for eight levels 20 indicating which of the eight levels, levels 1 to 8, the selected CQI's are at or a method of outputting relative value information.

Used sub-carrier selecting section 702 selects sub-carriers, for which CQI's are generated using SC 25 number information inputted by threshold value determining section 701, or sub-carriers, which have in advance a one-to-one correspondence with such

sub-carriers, as transmission sub-carriers, and outputs CQI's to spreading section 703.

Spreading section 703 subjects each CQI inputted by used sub-carrier selecting section 702 to spreading processing using CQI spreading code, allocates CQI signals to sub-carriers allocated by used sub-carrier selecting section 702 and outputs to multiplexer 122.

The CQI spreading code is a spreading code that differs every wireless communication apparatus 700 of each user and the same spreading code is used for the sub-carriers and CQI's of all of wireless communication apparatus 700 of each user.

The SC number information is not subjected to spreading processing by spreading section 703 because SC number information is not transmitted.

Multiplexer 122 multiplexes CQI's inputted by spreading section 703 and NACK signals or ACK signals inputted by modulating section 121 and outputs to S/P converter 123.

The multiplexed signal multiplexed at multiplexer 122 comes into a state where CQI of each sub-carrier is allocated to the sub-carrier itself, or where CQI's of each sub-carrier is allocated to a sub-carrier which has one to one correspondence with each sub-carrier.

The details of the method for allocating sub-carriers will be described later.

Next, a description is given using FIG.8 of a

configuration for a base station apparatus of Embodiment 3.

FIG.8 is a block diagram showing a configuration of a base station apparatus 800.

5 As shown in FIG.8, a base station apparatus 800 according to Embodiment 3 is of a configuration where de-spreading section 801 and sub-carrier determining section 802 are added in base station apparatus 200 of embodiment 1 shown in FIG.2.

10 In FIG.8, portions with the same configuration as for FIG.2 are given the same numerals and are not described.

Transmission data processing sections 803-1 to 803-n are comprised of control information extraction section 205, demodulating section 206, decoding section 207, 15 encoding section 209, transmission HARQ section 210, modulating section 211, encoding section 212, demodulating section 213, de-spreading section 801 and sub-carrier determining section 802.

Transmission data processing sections 803-1 to 803-n 20 are provided for the number of users and each of transmission data processing sections 803-1 to 803-n carries out processing on transmission data for transmission to one user.

De-spreading section 801 stores a plurality of 25 spreading codes used at wireless communication apparatus 700 of one user with which base station apparatus 800 is carrying out communication.

De-spreading section 801 then subjects all of the sub-carriers inputted by control information extraction section 205 to de-spreading processing using the stored de-spreading code and outputs this to sub-carrier 5 determining section 802.

Different spreading codes are stored at each of the de-spreading sections 801 of each of the transmission data processing sections 803-1 to 803-n because a different spreading code is used at each wireless 10 communication apparatus 700.

Sub-carrier determining section 802 determines a sub-carrier, of which de-spreading output inputted by de-spreading section 801 is greater than or equal to a threshold value, to be a sub-carrier selected at wireless 15 communication apparatus 700, and outputs SC number information of a sub-carrier with reception quality of greater than or equal to the threshold value to control section 208 and demodulating section 206.

Because SC number information is not transmitted 20 by wireless communication apparatus 700, sub-carrier determining section 802 stores in advance SC number information that is in common to wireless communication apparatus 700.

Further, the reception quality is taken to be a 25 relative value with respect to the pilot signal taking into consideration fluctuation in reception quality due to fading.

Decoding section 207 decodes the received signal inputted by demodulating section 206 and outputs CQI's for each of the designated number of sub-carriers included in the received signal to control section 208.

5 Moreover, decoding section 207 decodes the received signal inputted by demodulating section 206 and outputs a NACK signal or ACK signal included in the received signal to transmission HARQ section 210.

Control section 208 carries out scheduling based
10 on CQI's of wireless communication apparatus 700 for each user inputted by decoding section 207 and SC number information for wireless communication apparatus 700 of each user inputted by sub-carrier determining section 802, and MCS including M-ary numbers and encoding rates
15 etc. are adaptively selected.

In other words, control section 208 is capable of determining reception quality every sub-carrier for each wireless communication apparatus 700 using CQI's for each sub-carrier sent by wireless communication apparatus 700
20 of each user and SC number information for wireless communication apparatus 700 of each user inputted by sub-carrier determining section 802. MCS is then selected according to reception quality of each sub-carrier for each wireless communication apparatus
25 700.

Control section 208 is capable of allocating data to be transmitted to each wireless communication

apparatus 700 to sub-carriers of good reception quality at each wireless communication apparatus 700.

Control section 208 has knowledge of the number of usable sub-carriers and allocates transmission data sent 5 to each wireless communication apparatus 700 within the range of usable sub-carriers to each sub-carrier.

At this time, control section 208 carries out allocation, determining reception quality of a sub-carrier for which CQI's has not been transmitted by 10 wireless communication apparatus 700 as being the poorest.

Control section 208 outputs encoding rate information selected for each sub-carrier to encoding section 209, outputs modulation scheme information 15 selected for each sub-carrier to modulating section 211 and outputs sub-carrier information allocated to each wireless communication apparatus 700 using scheduling to a sub-carrier allocation section 215.

Next, a description is given using FIG.3 and FIG.9 20 of a method for selecting CQI's occurring at wireless communication apparatus 700 for allocation to sub-carriers, and a format for a transmission signal when transmitting selected CQI's.

It is possible to adopt two methods, a method where 25 CQI' of each sub-carrier is allocated to the sub-carrier itself, or a method where CQI' of each sub-carrier is allocated to another sub-carrier with a one-to-one

correspondence, as methods for allocating sub-carriers.

First, a description is given of a method for allocating CQI's of each sub-carrier to the sub-carrier itself.

5 In FIG.3, in the event that the reception quality of sub-carriers 11 to 21 and sub-carriers 34 to 41 is good from reception quality measurement results at the reception quality measuring sections 113-1 to 113-n, threshold value determining section 701 selects the CQI's
10 of sub-carriers 11 to 21 and sub-carriers 34 to 41, used sub-carrier selecting section 702 allocates CQI's for sub-carriers 11 to 21 to sub-carriers 11 to 21, and the CQI's for sub-carriers 34 to 41 are allocated to the sub-carriers 34 to 41.

15 On the other hand, threshold value determining section 701 does not select CQI's and SC number information for sub-carriers other than sub-carrier 11 to 21 and sub-carrier 34 to 41.

Next, a description is given of a method for
20 allocating CQI of each sub-carrier to another sub-carrier with a one-to-one correspondence:

In FIG.3, in the event that the reception quality of sub-carriers 11 to 21 and sub-carriers 34 to 41 is good from reception quality measurement results at
25 reception quality measuring sections 113-1 to 113-n, threshold value determining section 701 selects the CQI's of sub-carriers 11 to 21 and sub-carriers 34 to 41, used

sub-carrier selecting section 702 allocates CQI's for sub-carriers 11 to 21 to sub-carriers 22 to 32 each having a one-to-one correspondence, and the CQI's of sub-carriers 34 to 41 are allocated to the sub-carriers 5 51 to 57 each having a one-to-one correspondence.

On the other hand, threshold value determining section 701 does not select CQI's and SC number information for sub-carriers other than sub-carrier 11 to 21 and sub-carrier 34 to 41.

10 By storing sub-carriers having one-on-one correspondence with sub-carriers for which CQI's are generated at wireless communication apparatus 700 and base station apparatus 800 in advance, base station apparatus 800 can recognize which sub-carrier a received 15 CQI is for.

FIG.9 is a diagram showing a format for a signal transmitted from wireless communication apparatus 700 to base station apparatus 800.

As shown in FIG.9, control information constituted 20 of CQI's each having five bits and ACK signals or NACK signals for sub-carriers selected by a threshold value determination at threshold value determining section 701 is time division multiplexed and transmitted.

According to Embodiment 3, sub-carriers satisfying 25 reception quality of a threshold value or more designated by the base station apparatus are selected and CQI's are generated and transmitted for the selected sub-carriers.

By reducing the signal volume transmitted through the uplink, it is possible to increase the data capacity that can be transmitted and reduce power consumption and by reducing interference with respect to other wireless 5 communication apparatuses, it is possible to increase system capacity.

Moreover, according to Embodiment 3, CQI's are allocated to selected sub-carriers with good reception quality and base station apparatus 800 is therefore 10 capable of acquiring good quality CQI's.

Further, according to Embodiment 3, CQI generated for each sub-carrier is allocated to the sub-carrier itself. Base station apparatus 800 can therefore determine which sub-carrier CQI is for even without 15 transmitting SC number information and the volume of signal transmitted can therefore be reduced by the amount resulting from not sending the SC number information.

Still further, in the event that the duplex scheme is TDD, the propagation path characteristics of the uplink 20 and the downlink are substantially the same. It is therefore possible to use sub-carriers with good reception quality for the downlink as those for the uplink also.

In other words, it is possible to transmit a CQI 25 signal using a superior propagation path.

Further, according to Embodiment 3, designation upon selecting sub-carriers for which CQI's are generated may

be achieved simply by transmitting designation information designating a threshold value from the base station apparatus. It is therefore possible to reduce the amount of signal transmitted through the uplink 5 without increasing the amount of signal transmitted through the downlink.

According to Embodiment 3, the sub-carriers and CQI's are subjected to spreading processing using a spreading code specific to wireless communication 10 apparatus 700 of each user. In the event that CQI's are transmitted for the same sub-carrier by the wireless communication apparatus 700 of a plurality of users, it is possible for base station apparatus 800 to discriminate which wireless communication apparatus 700 of which user 15 a CQI has been sent from.

(Embodiment 4)

FIG.10 is a block diagram showing a configuration for a wireless communication apparatus 1000 according 20 to Embodiment 4 of the present invention.

As shown in FIG.10, wireless communication apparatus 1000 of the fourth embodiment is of a configuration where CQI generating section 114, encoding section 115 and modulating section 116 are excluded in the wireless 25 communication apparatus 100 of Embodiment 1 shown in FIG.1.

In FIG.10, portions with the same configuration as

for FIG.1 are given the same numerals and are not described.

SC selecting section 127 selects a number of sub-carriers designated by the CQI quantity information in order of good reception quality using CQI quantity information inputted by decoding section 107 and measurement value information inputted by the reception quality measuring sections 113-1 to 113-n.

SC selecting section 127 then outputs the selected sub-carriers as SC number information to encoding section 10 117.

Multiplexer 122 multiplexes SC number information inputted by the modulating section 118, and NACK signals or ACK signals inputted by modulating section 121 so as to generate transmission data and outputs the generated 15 transmission data to S/P converter 123.

Next, a description is given using FIG.11 of a configuration for a base station apparatus 1100 of Embodiment 4.

FIG.11 is a block diagram showing a configuration 20 for base station apparatus 1100.

In FIG.11, portions with the same configuration as for FIG.2 are given the same numerals and are not described.

Decoding section 207 decodes the received signal inputted by demodulating section 206 and outputs SC number 25 information included in the received signal to control section 208.

Moreover, decoding section 207 decodes the received

signal inputted by demodulating section 206 and outputs a NACK signal or ACK signal included in the received signal to transmission HARQ section 210.

Control section 208 is able to be aware of
5 sub-carriers of good reception quality at wireless communication apparatus 1000 of each user from SC number information for wireless communication apparatus 1000 of each user inputted by decoding section 207. Scheduling is therefore carried out based on a scheduling algorithm
10 in such a manner that transmission data is allocated to sub-carriers of SC numbers with good reception quality.

In other words, control section 208 carries out scheduling in such a manner that transmission data is allocated in order from the top of the SC number because
15 SC number is arranged in descending order of reception quality of sub-carriers.

Control section 208 outputs sub-carrier information for use in transmission to sub-carrier allocation section 215.

20 Encoding section 209 encodes transmission data at a fixed encoding rate set in advance and outputs to transmission HARQ section 210.

Modulating section 211 modulates transmission data inputted by transmission HARQ section 210 using a fixed
25 modulation method set in advance and outputs to multiplexer 214.

Next, a description is given of a method for selecting

CQI's at wireless communication apparatus 1000 and format for transmission signals during transmission of the selected CQI's, using FIG.3 and FIG.12.

In FIG.3, in the event that the reception quality 5 of sub-carriers 11 to 21 and sub-carriers 34 to 41 is good from the reception quality measurement results at reception quality measuring sections 113-1 to 113-n, SC selecting section 127 outputs SC number information only for sub-carriers 11 to 21 and sub-carriers 34 to 41.

10 On the other hand, SC selecting section 127 does not output CQI's and SC number information for sub-carriers other than sub-carrier 11 to 21 and sub-carrier 34 to 41.

FIG.12 is a diagram showing a format for a signal 15 transmitted from wireless communication apparatus 1000 to base station apparatus 1100.

As shown in FIG.12, control information outputted by multiplexer 122 is a signal of time-division-multiplexing of SC number information 20 comprised of six bits for sub-carriers selected at SC selecting section 127 and a one-bit ACK/NACK signal.

FIG.13 is a diagram showing a further example of a format for a signal transmitted from wireless communication apparatus 1000 to base station apparatus 25 1100.

As shown in FIG.13, control information outputted by multiplexer 122 is signal of

time-division-multiplexing of SC number information of 64-bits from the top for each of the 64 sub-carriers and a one-bit ACK/NACK signal.

The SC number information is information
5 time-division-multiplexed in order from the first sub-carrier of the 64 sub-carriers, with SC number information for sub-carriers that are selected being indicated as "1", and SC number information for sub-carriers that are not selected being indicated as
10 "0".

Therefore, bit 1, bits 2 to 10, bits 22 to 33 and bits 42 to 64 are indicated as "0", and bits 11 to 21 and bits 34 to 41 are indicated as "1".

According to Embodiment 4, a number of sub-carriers
15 designated by a base station apparatus as having good reception quality are selected and SC number information is sent to the selected sub-carriers. The volume of signal transmitted through the uplink can therefore be reduced compared to the case where CQI's and SC number
20 information are both transmitted. It is therefore possible to increase the data capacity that can be transmitted and reduce power consumption, and increase system capacity by reducing interference with respect to other wireless communication apparatuses.

25 Further, according to Embodiment 4, designation upon selecting sub-carriers for which CQI's are generated may be achieved simply by transmitting designation

information designating the number of CQI's from the base station apparatus. It is therefore possible to reduce the amount of signal transmitted through the uplink without increasing the amount of signal transmitted
5 through the downlink.

Moreover, according to Embodiment 4, a base station apparatus is capable of carrying out encoding using encoding rates fixedly set in advance, modulation and suchlike. It is then possible to make circuits and
10 apparatus smaller and reduce manufacturing costs by simplifying processing for encoding processing and modulation processing and so on.

(Embodiment 5)

15 FIG.14 is a block diagram showing a configuration for a wireless communication apparatus 1400 according to Embodiment 5 of the present invention.

As shown in FIG.14, wireless communication apparatus 1400 of Embodiment 5 is of a configuration where encoding section 115, modulating section 116, encoding section 20 117, demodulating section 118, and SC selecting section 127 are removed, and threshold value determining section 1401, CQI spreading code generating section 1402, used sub-carrier selecting section 1403 and spreading section 25 1404 are added in wireless communication apparatus 100 of Embodiment 1 shown in FIG.1

In FIG.14, portions with the same configuration as

for FIG.1 are given the same numerals and are not described.

Threshold value determining section 1401 as a selecting section selects only CQI's with reception quality greater than or equal to the threshold value using 5 CQI's, which are reception quality information for selection use and inputted by CQI generating section 114, and CQI threshold value information, which is inputted by decoding section 107, outputs the selected CQI's to the CQI spreading code generating section 1402, and 10 outputs SC number information for selected CQI's to the used sub-carrier selecting section 1403.

As with the threshold value determining section 601 of Embodiment 2, threshold determining section 1401 is capable of threshold value determination adopting either 15 of a method of outputting eight levels of information indicating which of the eight levels, levels 1 to 8, the selected CQI's are at or a method of outputting relative value information.

This is not limited to selecting CQI's greater than 20 or equal to a threshold value from CQI's for all of the sub-carriers, and it is also possible to select sub-carriers with reception quality greater than or equal to a threshold value before generating CQI's and only generating CQI's of the selected sub-carriers.

25 CQI spreading code generating section 1402 constituting a spreading code selection section has a reference table that stores CQI spreading code

information which is spreading code selection information for providing a relationship between associating CQI's and spreading codes.

CQI spreading code generating section 1402 selects 5 spreading codes by referring to CQI spreading code information using CQI's inputted by a threshold value determining section 1401 and outputs selected spreading code information to spreading section 1404.

Spreading codes in the CQI spreading code 10 information are codes that are different at wireless communication apparatus 1400 of each user and are codes that are different for each CQI.

Used sub-carrier selecting section 1403 allocates an ACK signal or NACK signal as an error determination 15 signal inputted by modulating section 121 to a sub-carrier selected using SC number information inputted by threshold value determining section 1401 and outputs to spreading section 1404.

In the event that a plurality of SC number information 20 are inputted from threshold value determining section 1401, used sub-carrier selecting section 1403 allocates ACK signals or NACK signals to a plurality of sub-carriers reported using the SC number information.

Spreading section 1404 subjects sub-carriers 25 allocated with ACK signals or NACK signals inputted by used sub-carrier selecting section 1403 to spreading processing using spreading codes inputted by the CQI

spreading code generating section 1402 and outputs to multiplexer 122.

Next, a description is given using FIG.15 of a configuration for a base station apparatus of Embodiment 5 5.

FIG.15 is a block diagram showing a configuration for base station apparatus 1500.

As shown in FIG.15, base station apparatus 1500 of Embodiment 5 is of a configuration where a de-spreading section 1501 and a determining section 1502 are added in base station apparatus 200 of Embodiment 1 shown in FIG.2.

In FIG.15, portions with the same configuration as for FIG.2 are given the same numerals and are not described.

15 Transmission data processing sections 1503-1 to 1503-n are comprised of control information extraction section 205, demodulating section 206, decoding section 207, encoding section 209, transmission HARQ section 210, modulating section 211, encoding section 212, 20 demodulating section 213, de-spreading section 1501 and determining section 1502.

Transmission data processing sections 1503-1 to 1503-n are provided for the number of users and each of the transmission data processing sections 1503-1 to 25 1503-n carries out processing on transmission data for transmission to one user.

De-spreading section 1501 stores in advance a

plurality of spreading codes used at wireless communication apparatus 1400 of one user with which base station apparatus 1500 is carrying out communication.

De-spreading section 1501 then subjects all of the 5 sub-carriers inputted by control information extraction section 205 to de-spreading processing using the stored de-spreading code and outputs to determining section 1502.

De-spreading sections 1501 of each of transmission 10 data processing sections 1503-1 to 1503-n stores in advance a different spreading code because a different spreading code is used at each wireless communication apparatus 1400.

Determining section 1502 has a reference table that 15 stores CQI spreading code information for providing a relationship between the spreading code and CQI's, and stores spreading codes used by wireless communication apparatus 1400 of one user.

Determining sections 1502 of each of transmission 20 data processing sections 1503-1 to 1503-n stores in advance a different spreading code because a different spreading code is used at each wireless communication apparatus 1400.

CQI spreading code information is in common with 25 CQI spreading code generating section 1402.

Determining section 1502 obtains a de-spreading output for received signals inputted by de-spreading

section 1501 every sub-carrier, and compares the largest de-spreading output with a threshold value (a third threshold value) every sub-carrier.

Determining section 1502 determines sub-carriers 5 whose largest de-spreading outputs are greater than or equal to the threshold value are sub-carriers selected by wireless communication apparatus 1400, selects CQI's of sub-carriers whose largest de-spreading outputs are greater than or equal to the threshold value by referring 10 to CQI spreading code information using spreading codes employed in de-spreading of the largest de-spreading outputs, and outputs the selected CQI's to control section 208.

At this time, the de-spreading output is expressed 15 as a relative value with respect to the received signal power of a pilot, taking into consideration fluctuation in received signal power due to fading.

Demodulating section 206 then de-modulates an ACK signal or NACK signal inputted by the determining section 20 1502 and outputs to decoding section 207.

Decoding section 207 then outputs the results of demodulating the ACK signal or NACK signal inputted by demodulating section 206 to transmission HARQ section 210.

25 Control section 208 carries out scheduling based on a scheduling algorithm using CQI's for wireless communication apparatus 1400 of each user inputted by

determining section 1502, and adaptively selects MCS's for the M-ary numbers, encoding rates and suchlike.

In other words, control section 208 is capable of determining reception quality every sub-carrier for each 5 wireless communication apparatus 1400 using CQI's every sub-carrier inputted by determining section 1502. MCS's are then selected according to reception quality of each sub-carrier for each wireless communication apparatus 1400.

10 Control section 208 has knowledge of the number of sub-carriers and it is possible to use and allocates transmission data to be sent to each wireless communication apparatus 1400 within the range of usable sub-carriers to each sub-carrier.

15 At this time, control section 208 carries out allocation, determining reception quality of a sub-carrier for which CQI's has not been inputted by determining section 1502 as being the poorest.

Control section 208 outputs encoding rate 20 information selected for each sub-carrier to encoding section 209, outputs modulation scheme information selected for each sub-carrier to modulating section 211 and outputs sub-carrier information allocated to each wireless communication apparatus 1400 using scheduling 25 to sub-carrier allocation section 215.

Next, a description is given using FIG.3 of a method for selecting sub-carriers at wireless communication

apparatus 1400.

Used sub-carrier selecting section 1403 allocates ACK signals or NACK signals to sub-carriers 11 to 21 and sub-carriers 34 to 41.

5 Control information multiplexed at multiplexer 122 is a signal resulting from time-division-multiplexing of a plurality of ACK signals or NACK signals.

In the case of FIG.3, a plurality of ACK signals or NACK signals are transmitted but as the ACK signals 10 or NACK signals are one bit whereas the five bits are required for CQI's, the overall quantity of signal can be reduced.

According to Embodiment 5, a sub-carrier of good reception quality is selected, and an ACK signal or NACK 15 signal is allocated to the selected sub-carrier. By reducing the amount of signal transmitted on the uplink, it is possible to increase the data capacity that can be transmitted that can be transmitted and reduce power consumption, and, by reducing interference with respect 20 to other wireless communication apparatuses, it is possible to increase system capacity.

According to Embodiment 5, dual purpose use of the ACK signal or NACK signal indicative of whether or not re-transmission is required and reception quality 25 information which is CQI's is possible, and the CQI's and SC number information are not transmitted. The amount of signals transmitted through the uplink is therefore

reduced to an extreme level.

Further, according to Embodiment 5, designation while selecting sub-carriers for which CQI's are generated may be achieved simply by transmitting 5 designation information designating the number of CQI's from the base station apparatus. It is therefore possible to reduce the amount of signal transmitted through the uplink without increasing the amount of signal transmitted through the downlink.

10 In Embodiment 5, wireless communication apparatus 1400 spreads sub-carriers by selecting user-specific spreading codes and spreading sub-carriers allocated with ACK signals or NACK signals. However, this is by no means limiting, and it is also possible to perform scrambling 15 by selecting user-specific scrambling codes and allocating ACK signals or NACK signals using the selected scrambling codes.

In Embodiments 1 to 5, 64 sub-carriers are allocated 20 within communication band F1 but this is by no means limiting and it is also possible to allocate an arbitrary number of sub-carriers other than 64.

The wireless communication apparatus of Embodiments 1 to 5 may also be applied to a communication terminal 25 apparatus.

In Embodiments 3 to 5, sub-carriers to be selected are determined using a threshold determination for

reception quality for each sub-carrier, but it is also possible to select just the number of sub-carriers notified by an upper order station as in Embodiment 1.

Each functional block employed in the description
5 of each of the aforementioned embodiments may be typically implemented as an LSI which is an integrated circuit.

These may be integrated into chips individually, or may be integrated into chips in such a manner that each includes part or all of them.

10 An LSI is adopted here but this may also be referred to as "IC", "system LSI", "super LSI", or "ultra LSI" depending on a difference in degree of integration.

Further, a method of circuit integration is not limited to LSI's, and implementation using dedicated
15 circuitry or general purpose processors is also possible.

After LSI manufacturing, utilization of a programmable FPGA (Field Programmable Gate Array) or a reconfigurable processor where connections and settings of circuit cells within an LSI can be reconfigured is
20 also possible.

Further, if circuit integration technology comes out to replace LSI's as a result of the advancement of semiconductor technology or another derivative technology, it is, of course, possible to carry out
25 functional block integration using such technology.

Application in biotechnology is also possible.

As described above, according to the present

invention, by reducing the amount of signal transmitted, it is possible to increase the data capacity that can be transmitted and reduce power consumption and, by reducing interference with respect to other wireless 5 communication apparatuses, it is possible to increase system capacity.

This specification is based on Japanese patent application No.2003-288162, filed on August 6th, 2003, 10 the entire content of which is expressly incorporated by reference herein.

Industrial Applicability

The wireless communication apparatus and reception 15 quality reporting method of the present invention are capable of increasing data capacity that can be transmitted and reducing power consumption by reducing the amount of control signal transmitted, have an advantage of increasing system capacity by reducing 20 interference with respect to other wireless communication apparatuses, and suitable for use in giving reporting of reception quality for wireless communication apparatus.